APPARATUS AND METHOD FOR CUTTING AND HARVESTING INFESTATIONS OF AQUATIC VEGETATION AND/OR SKIMMING ALGAE/FLOATING VEGETATION

This patent application is a continuation in part of earlier patent application No. 10/244,282 filed 09/16/2002 by Clarence W. Shonnard and entitled APPARATUS AND METHOD FOR CUTTING AND HARVESTING INFESTATIONS OF AQUATICS VEGETATION IN SHALLOW AREAS OF WATER BODIES AND NOW US PATENT

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BACKGROUND OF THE INVENTION

(1) Field of the Invention

The invention relates to an apparatus and method for cutting and harvesting infestations of bottom growing aquatic vegetation and/or skimming algae/floating vegetation in shallow areas of water bodies.

(2) Description of the Prior Art

Bottom growing nuisance aquatic plants and floating algae/floating vegetation and degradation of waters for

swimming, boating, fishing, aesthetic and health aspects by lake users and waterfront property owners. Currently these plants can be removed by physical, mechanical, chemical and biological methods each with significant drawbacks.

Physical methods, such as barriers disturb water-bottom ecology and often result in gassing of decomposing plant like vegetation under the barrier. Examples of such mat material are filtration mats, discarded rugs and thin sheets of metal plate.

Mechanical bottom cutting and drag devices such as commonly used rake like tools and typical garden type cultivators that have transverse bars, tines and handles stir up bottom sediments which release nutrients back into the waters and disturb water bottom ecology. These nutrients enhance further aquatic plant growth and digging up the bottom sediments can have a negative impact on the lake bottom ecology.

The following patents are examples of bottom, metal, drag-type cutters which dig up bottom sediment as well as not integrally harvesting the floating cut aquatic plants. These floating plants can then reestablish themselves in other areas of the water body. A further disadvantage of these water bottom drag-type cutters is that they are prone to be blocked or other wise interfered with during cutting by rocks, logs and debris that have accumulated on the lake bottom. US 6,250,054 Kramer; US 2,065,733 Pearson; US 2,702,975 Friesen; US 2,790,297 Gardner; US 3,601,956 Akermanis; US 3,601,956; US 4,137,693 Thompson et al; US 4,375,299 Laven; US 3,863,237 Doer; US 4,696,149 Hawk; US 4,852,337 Peterson; US 5,189,867 Schmidt; and US 5,493,850 Torkelson;

each show methods for cutting plants using a drag bar with a cutting edge. US 4,999,982 Kriger describes the use of a dragging bar grate for cutting aquatic plants. US 4,583,353 Shaver shows a triangular drag bar for cutting plants.

Chemical and biological methods are under investigation. However, there is concern about these methods, because of questions of effectiveness, damage to water ecology, known and unknown water related human health impacts and possible liability considerations for the user.

Another type of plant cutting involves the commercial mechanical lake weed harvesters having reciprocating knives and conveyors. These machines with on-board power are heavy, complicated, costly and hazardous. Further, these machines are unworkable in shallow areas of lakes and other bodies of water, because of hydraulic boat draft problems resulting in grounding of the harvester and engine cooling water problems from intake of lake bottom sediments into the engine. Examples of commercial powered and mechanized lake weed harvesters are US 4,616,588 Caddick; US 3,238,708 Zickeford; and US 5,404,696 Vasby. These harvesting units are expensive, require considerable maintenance, need US Coast Guard permits in US navigable waters and require marine Workman's Compensation insurance under the Jones Act.

There are also wheeled garden rakes that are used on dry land. Codding US 4,945,996 and Foeller US 5,287,935 are examples of such dry land garden rakes.

SUMMARY OF THE INVENTION

A principal object of the present invention is to provide an effective and very manufacturable at a reasonable cost apparatus and method for using the same for cutting and harvesting infestations of aquatic floating algae and vegetation in shallow areas of water bodies, such as lakes.

A further object of the invention is to provide an improved, versatile, light-weight multifunctional harvesting device and method for skimming floating algae and other floating growing aquatic plants that minimizes the problems of the current practices and can be operated manually by one person in shallow waters.

A further object of the invention provides a method that provides enhanced mobility of both the operator and the harvester by use of an anchored floating mooring with an attached pulley and rope connected to the harvester and controlled manually by the operator to efficiently harvest the bottom vegetation and/or the floating algae or floating vegetation.

A still further object of the present invention is to provide an improved multifunctional mobile harvesting device for lake bottom growing plants and/or algae/floating vegetation and methods that guide plant stems into a cutting device above the water body bottom in shallow areas, collects the cut aquatic plants for

transport to onshore sites and eventual use in composting for garden and agricultural activities, that can be operated by one person with or without onshore power devices and that removes phosphorus contained in the cut vegetation from the water body.

These objects are accomplished by providing an improved harvesting apparatus that cuts or skims from the water surface aquatic plants at a predetermined distance above the lake or the like bottom using a planar horizontal deck with a plurality of closely spaced planar metal bars that efficiently guide the plant stems into confined spaces between the plurality of transverse bars until the stems become compacted within the spaces between the bars and eventually against the transverse stainless steel filaments or knife positioned at a predetermined distance from the distal end of the metal deck bars where the steel filaments cut the wedged plant stems. The harvesting device with planar metal deck bars and transverse cutting filaments provide underwater cutting of the plant stems by movement of the harvester in either the forward or the reverse direction of motion with attachable cutting devices at both ends of the harvester.

A flexible plastic grid integral with the harvester collects the cut or skimmed algae or aquatic plants containing phosphorus and retains the plants until transported on the harvester to an onshore location for manual dumping by simple removal of the appropriate segments of the flexible plastic grid to the front or to the back of the harvester. The cut or skimmed plants can then be dewatered, composted and the contained phosphorus used for garden or other agricultural purposes.

The harvester is provided with air-filled or a combination of water and air filled plastic wheels for easy mobility and buoyancy adjustment that can be moved by one person across the bottom of the water body to minimize the disturbance of the lake bottom sediment ecology as well as passing over obstacles of rocks, logs and debris on the lake bottom and that can be used to float the harvester so that algae and floating vegetation can be skimmed from the water surface.

The harvester can be operated by one person in the water bottom or water skimming mode using a rigid handle that can move up or down vertically over a 180 degree arc for pulling or pushing the harvester apparatus in the forward or reverse direction as needed, with or without the use of onshore auxiliary power and that cuts aquatic plants moving in either direction. The accessory plant cutting attachments needed for variation in plant stem cutting characteristics can be attached, such as with bolts to either end of the harvester deck.

The harvester buoyancy is balanced by the apparatus's weight and hydraulic buoyant forces by use of hollow plastic wheels having air/water therein added to the deck that optimizes wheel penetration into the bottom sediments thereby enhancing manual mobility of the harvester by one person in shallow waters. This also minimizes the disturbance of the water body bottom sediment ecology.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings forming a material part of this description, there is shown:

Fig. 1 is a perspective view of the aquatic plant cutting and harvesting apparatus of the present invention.

Fig. 2A shows a plan view of the harvesting apparatus including hollow wheels and optional floatation and/or weight adjustment device of pipe tube being water or air filled.

Fig. 2B is a front elevation view of the apparatus showing the relationship of the plant cutting filament to the water body bottom.

Fig. 2C is a side elevation view of the apparatus showing the vertical angle bars supporting flexible plastic grid or net for collecting cut plants.

Fig. 3 illustrates the deck frame assembly with vertical angle bars for support of plastic grid and adjusting height of cutting bar above the lake bottom.

Fig. 4 is a perspective view of the handle components for pulling or pushing the harvesting apparatus.

Figs. 5A, 5B, 5C and 5D show three methods and optional devices of the invention for abrading and cutting bottom growing aquatic plants.

Figs. 6A, 6B, 6C and 6D display assembly details by elevation and plan views of two methods of the invention for cutting aquatic plant stems using easy bolt-on bars.

Figs. 7A and 7B illustrate the method of manually operating the harvesting device on lake bottom by an elevation view of the vertically mobile handle and method of maintaining the plant cutting devices clear of bottom object and debris.

Figs. 8A and 8B show perspective views of the harvesting apparatus being pulled by offshore and onshore optional auxiliary powered devices.

Figs. 9A, 9B and 9C show side and overhead views for operating the harvesting apparatus in both the bottom and skimming harvesting modes.

Figs. 10A and 10B show views of the hollow wheels that can contain air and water to provide mobility and floatation adjustment for the harvester in either the bottom harvesting or skimming harvesting mode.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments disclose the novel multifunctional manual mobile harvesting device for lake or the like bottom growing plants and methods that guide the plant stems into a cutting device above the water body bottom in shallow areas, collects the cut aquatic plants for transport to onshore sites. The harvester can also be floated by means of plastic air filled wheels that allow skimming of the algae or other floating vegetation on the water. Eventually the collected plants can be composted for garden and agricultural use. This removes phosphorus contained in the cut vegetation from the water body. The harvester can be operated by a single person with or without onshore power devices.

Referring now more particularly to Figs. 1 through 7B and in particular to Fig. 1 there is illustrated a mobile, multifunctional apparatus and method for cutting and harvesting nuisance bottom growing aquatic plants. The harvesting apparatus includes a frame 6 attached to an axel 2 by for example "U" bolts 9. Wheels 1 on axel 2 are held in place by washers 4 and cotter pins 3 to provide mobility for the harvester 1A.

Referring additionally to Figs. 2A, 2B and 2C wherein Fig. 2A is an overhead view, Fig. 2B is a front elevation view and Fig. 2C is a side elevation view of harvester 1A of Fig. 1 without the push/pull handle 17.

Referring to Fig. 3, the harvester deck 6 includes a horizontal, rectangular frame assembly of planar horizontal aluminum angle bars 8A, 8B, 8C, and 8D connected as shown with, for example bolts 23 with washers and nuts for attachment of a deck

bottom 6 which supports the harvester 1A load of harvested aquatic vegetation. The deck 6 could be made of perforated plywood, plastic or metal. The mobile harvester 1A deck frame 6 includes front and back aluminum angles 8C and 8D which are assembled with vertical component of the aluminum angle bars 8C and 8D directed downward toward the lake bottom B for attachment of optional cutting bars 20A as seen in Figs. 5A, 5B, 5C, 5D with a plurality of planar, aquatic plant stem guides and compaction bars 5 with transverse stainless steel cutting filament 7 having, for example wire diameter of the order of 0.01 to 0.029 inches. An optional attachment of replacement bar is shown in Fig. 5D using accessory transverse add-on bar 20A with triangular knives 20B and metal cutting filament 7 or with optional attachment of replacement bar 20A with planar threaded fastener guides 20 with transverse cutting filament 7. Aquatic plant cutting filament 7 is fastened to bars 5, 20B or 20C by filament tension hardware 24 shown in Figs. 5B, 5C and 5D. It is an option of the operator to use the stainless steel cutting filament 7 with methods 20B or 20C to enhance plant stem cutting efficiency where stem coarseness, strength or number of plant stems per square foot is more efficient for any given situation. Add-on optional attachment bars with 5, 20B or 20C are simply bolted onto the front or back aluminum angles 8C or 8D of the harvester frame 6. Planar bars 5, triangular cutting blades 20B and threaded fasteners 20C guide and wedge plant stems into transverse cutting filament 7 which is common to 5, 20B or 20C alternatives.

Obviously, transverse cutting filament 7 or optional device could be attached in a moveable planar mode, for example, with a spring attached at one end of device 7

connected by rope to a lever on handle 17 (not shown in drawings)and lever actuated manually by harvester operator to move cutting device transversely through aquaticd vegetation to enhance efficiency.

Referring to Fig. 5A, a fragmented and exploded view of planar deck 6 is shown wherein plant stem guide compaction bars and stainless steel filament 7 illustrate aquatic plant stems 29 cut typically 6 to 8 inches above the lake bottom being compacted within the spaces between guide bars 5 and wedged against metal cutting filament 7 wherein plant stems 29 are severed and cut plants 30 flow and are collected into plastic grid or net 12. Obviously, the comaction and indexing process is applicable to cutting methods 20B and 20C.

Referring to Figs. 1, 3, and 5A, 5B, 5C, 5D, an important objective of the present invention is shown wherein the bottom growing aquatic plants 30 in Fig. 5A are severed at a predetermined distance above the water body bottom B to minimize the disturbance of the lake bottom sediment ecology which could otherwise result in the release of benthic phosphorus back into the water and thereby enhancing more aquatic plant growth. This is achieved by limiting vertical movement of the cutting bars 20A (transverse filament), 20B (planar, transverse triangular mowing knives) and 20C(planar screw-type bar guides), selectively attached to transverse harvester deck bars 8C and 8D, by use of eyebolts 18A, 18B, 18C, 18D through harvester deck vertical angles 10A, 10B, 10C, 10D at the appropriate distance from deck 6, and eyebolts 18E, 18F through rigid harvester handle 17 at the appropriate distance from axel 2 to line up with eyebolts

18A, 18B, 18C, 18D. The length of chains 14A, 14B are adjusted so that quick links 14C, 14D when connected optionally to eyebolts 18A, 18B and chain links 14A, 14B through handle 17 effectively limit the aquatic plant cutting distance of bars 20A, 20B and 20C to a minimum of for example, about 6 inches above lake water bottom B. Fig. 3 shows holes where bolts 13 will connect vertical and horizontal angle bars with bolts 13 (not shown).

In addition to cutting aquatic vegetation above said water body bottom B as described above the present invention positions the aquatic plant cutting devices 20A, 20A and 20C at sufficient distance above said water bottom B so that harvester 1A can be pulled or pushed by one person above and over the most common bottom laying objects, such as rocks R, logs L or debris D that would impede or block the manual pulling or pushing of the harvester along the water body bottom B as shown in Fig. 7A and Fig. 7B.

A improved mobile multifunctional apparatus and method is shown in Fig. 1 and Figs. 2A, 2B, 2C, 2D where sections of flexible, plastic grid or net illustrated as 12A, 12B, 12C, 12D, 12E, 12F collect cut aquatic plant stems 29 as the harvester is pulled or pushed through the water body. The plastic grid sections are attached to the vertical aluminum angle bars shown in Fig. 3 as 10A, 10B, 10C 10D of the harvester 1A by means of four upper and four lower eyebolts fastened to vertical aluminum angle bars using spring loaded metal snap hooks as needed to connect the plastic grids to the

harvester. Other means could be used to secure the plastic grid or net to the harvester frame.

The front and back sections of plastic grid 12C and 12D as seen in Fig. 1 are removable depending on the direction of said harvester 1A movement such that the cut aquatic plants 29 flow into the harvester plastic grid 12A, B, C, D, E opposite to direction of motion of said harvester where the front section of the plastic grid 12D has been temporarily removed for cutting. A section of plastic grid 12F previously placed on the deck 6 of said harvester 1A before harvesting is started, is connected by snap hooks at the bottom of back plastic grid 12D. 12E is the top plastic grid as seen in Fig. 1. For dumping the harvested water body vegetation at an onshore location the back section of said plastic grid 12D is disconnected from the harvester aluminum frame verticals 10B and 10C. By manually pulling plastic grid section 12D from the back to the front of the harvester 1A, for example the cut vegetation is deposited onshore for dewatering and subsequent transporting to a composting location for reuse of the nutrient phosphorus contained in the removed vegetation for gardening or other agricultural projects.

The push or pull handle 17 shown in Figs. 1A, 4, and 7A can be operated by one person from either end of said harvester. The vertically movable handle 17 is comprised of a rigid pipe and appropriate fittings and is connected to said harvester 1A at axel 2 inside of each wheel 1 to rotatable, pipe "Tees" 16 at the inside of each wheel of said harvester 1A as seen in Fig. 2A. The "Tees" 16 are fitted with nipple inserts on the long axis and over axel 2 to take up slack of vertically mobile handle 17. The handle

17 extending from the harvester axel 2 at each wheel 1 are configured to a single rigid handle using standard pipe and fittings. A grip 19 composed of piping is useful for manually pushing or pulling harvester 1A offshore or on shore. As illustrated in Fig. 7B, the handle 17 is moveable vertically in an arc of 180 degrees to pull or push said harvester 1A, cut and harvest aquatic plants by simply moving the handle 17 overhead to the opposite end of the harvester.

Referring to Figs. 6A and 6B, there is shown an optional cutting structure and method that use planar triangular knives. The planar triangular knives are attached with bolts to aluminum angle bars 20A and frame angle 8C at either front or back of the harvester frame. The transverse cutting filament 7 is shown, for example positioned about ½ inch from the "V" notch formed by adjacent triangular cutting blades.

Referring now to Fig. 6C and Fig. 6D, there is shown a cutting structure and method that uses vertical plant stem guide and compaction bars 5 bolted to optional attachment bar 20A. Transverse cutting filament 7 is shown passing through the bars 5 at a distance of, for example 1 inch from the support bar 20A.

Referring to Fig. 8A and 8B, it is shown how the harvester can be used with the aid of onshore or offshore power equipment. Ring 19A is provided at handle grip 19 for optional connection by rope, chain or cable to an offshore powered device, such as a

boat seen in Fig. 8A or onshore tractor as seen in Fig. 8B or winch to move harvester 1A.

The mobility of the manual harvester 1A can be improved by balancing the loaded equipment weight against the harvester buoyancy. Since the in-water density of the harvested aquatic plants is about the same as water, the in-water weight of the harvester 1A may be considered a constant whether full or empty of harvested vegetation 29, except possibly for friction factors. By adjusting air volume in the plastic wheel 1 and if necessary by attachment of a variable floatation device 31 which can be air-filled or water-filled wheel to the harvester deck 6, the wheel-load on the lake bottom B is adjusted for maximum mobility of the harvester 1A for a given situation of lake bottom B firmness.

The following is the summary of a numbered part of this harvesting apparatus.

1A harvester

1 hollow wheels filled with air/water mixture

2 steel axel for harvester wheels

3 cotter pin through axel to hold wheels in place

4 washers to hold wheels in place against cotter pins

5 one of a plurality of vertical closely spaced planar metal bars to guide plant stems into the cutting filament 7

6 harvester deck

7 transverse stainless steel filament or optional manual movable cutting devices such as pulp wood saw or band saw blades numerous teeth for cutting plant stems

8A,B,C,D horizontal aluminum angle deck frames to support deck and aquatic plant cutting attachments

9 pipe "U" bolts for fastening deck frame to harvester axel

10A,B,C,D vertical aluminum angle bars to support flexible plastic grid that collects cut aquatic plants

11 galvanized metal reinforcing plates for support of vertical aluminum angle bars

12A,B,C,D,E separate sections of flexible plastic grid with rectangular openings to collect cut aquatic plants

13 bolts for fastening the deck to horizontal aluminum angle deck frame

14A,B chains to control height of cutter bar above lake bottom

14C,D metal quick links to connect chain and handle eyebolt to limit vertical downward movement of the deck by connecting to 18A and 18B (Fig. 7B)

15 eye bolt through aluminum vertical angle for

attachment of flexible plastic grid with snap hooks

16 pipe "Tees" over axel to attach movable harvester

17 harvester handle

18 A,B eye bolts through harvester handle to limit downward vertical movement of harvester deck

18C,D,E,F eye bolt through the deck vertical aluminum angles 10A, 10B, 10C 10D for attachment to chains to control vertical height of deck above lake bottom

19 handle grip of harvester 1A

19 A steel ring connection for pulling harvester, on shore or off shore with optional use of power devices

20A accessory transverse aluminum angle bar for attachment of optional cutting methods such as triangular knives, metal guide bars threshold guide bars and metal cutting filaments

20B planar triangular knives and metal cutting filaments

20C threaded guide bolts bars that abrade plant stems while being compacted against metal stem cutting filaments

21 rope or cable for pulling harvester with optional powered device offshore or onshore

22 pipe and fittings for extension of harvester handle assembly

23 harvester assembly bolts for each frame and attachable bars with cutting devices

24 metal filament tension fitting

25 PVC pipe that is filled with either sand or air for harvester buoyancy adjustment

26 bolts that fasten galvanized triangular reinforcing plates 11 to deck frame

29 cut vegetation stems

30 aquatic plants

31 optional buoyancy control tubes for harvester deck

The related Shonnard patent cited above highlights the bottom vegetation harvesting method and not the skimming method of removing algae and floating vegetation from water surfaces. However, that patent does refer to wheels filled with air or other media for adjusting the buoyancy and therein the distance of the harvester deck above the water body bottom. This implies wheels of various sizes filled with a mixture of air and water for the purpose of adjusting the harvester buoyancy so as to function (1) as a floating surface skimming device; (2) a harvesting apparatus moving along the water bottom and (3) a harvester functioning at any distance between the water surface and the bottom of the water.

Additionally, in both surface skimming and lake bottom harvesting modes use of an anchored floating mooring buoy with a pulley and marine ropes attached to the

harvester handle 17 in deep waters allows the harvester 1A to be moved forward or in reverse direction manually from shallow waters when buoyancy factors in deeper water result in the operator losing foot traction on the water bottom.

Referring to Fig. 9A, there is shown a side view of the harvester 1A in the skimmer mode. In this mode the buoyancy of the plastic wheels are adjusted with air and water so that the harvester floats and can skim the algae and floating vegetation (not shown). The use of the anchor tied to a mooring ball with a rope or chain is shown. A pulley is attached to the mooring ball by rope to the harvester and to a float controlled by the manual operator in shallow water. With this method it is possible to, with control, do the skimming of a water surface.

Referring to Fig. 9C, there is shown a side view of a harvester 1A in the deep water bottom harvesting mode. In this mode the buoyancy of the plastic wheels are adjusted with air and water so that the harvester is at or close to the bottom to harvest and cut vegetation without damaging the bottom of the water body. The anchor and pulley operation method is the same as with Fig. 9A and controlled cutting of the vegetation is possible without actually seeing the vegetation in deep water.

Referring to Fig. 9B, there is shown an overhead view that is applicable to both the skimming and bottom cutting modes. There is shown a float 40 that is attached to handle 17 that allows the reversing harvester direction from shallow water by the manual operator.

Referring to Fig. 10A and Fig. 10B, there is shown one of the preferred wheels 1 that can be used as the means for providing the needed buoyancy of the harvester 1A. This wheel can be fabricated by molding polyethylene plastic into the hollow wheel shape. There are a chosen number of openings 42 that extend into the hollow wheel. These openings allow water/air to enter the hollow wheel to adjust the buoyancy of the wheel. Plugs 44 can be used to limit the air/water entrance into the wheel and to maintain the desired buoyancy.

Plugs 44 can be, for example, expandable and removable rubber or plastic plugs similar to those used in the stern of row or motor boats to drain rain water from the boats. By inserting or removing the plugs 44 from the preferred number of four holes drilled in the hollow plastic wheels 1, harvester buoyancy can be adjusted by the ratio of air to water inside the hollow wheels for manual harvesting operations along the water body bottom or for skimming at the surface of the water body with the multifunctional apparatus.

While the invention has been particularly shown and described with reference to the preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made without departing from the spirit and scope of the invention.

What is claimed is: